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COVER: On 2 Sept 1995, 50 years after World War II ended on the deck of USS *Missouri* in Tokyo Bay, the National Naval Medical Center, Bethesda, MD, dedicated "The Unspoken Bond," a sculpture honoring corpsmen who served with the Marines during the Pacific war. Story on page 1. Photo by HA Sam Kim, NNMC Bethesda, MD.

Sculpture Unveiled in Bethesda Ceremony

RADM Richard Ridenour; the statue's benefactor, Dr. Will Laing; LGEN George Christmas; and sculptor, Peter Wilde. Right: NNMC chaplains, CDR James MacNew (left), and LCDR Jon Black, prepare to bless "The Unspoken Bond."

Photos by JOSA Jerome Pollos and JO3 Kevin Briscoe, NNMC Public Affairs Office, Bethesda, MD

The human condition, with all its strengths and frailties, was brought to life on 2 Sept 1995 at the National Naval Medical Center (NNMC), Bethesda, MD, with the unveiling of the "The Unspoken Bond," a sculpture depicting the bond between Navy corpsmen and the Marines with whom they serve. The ceremony commemorated the 50th anniversary of the end of World War II.

Among the dignitaries present were RADM Richard I. Ridenour, NNMC commanding officer; sculptor Peter Wilde; and Dr. William H. Laing, who commissioned the statue. The keynote speaker for the dedication was LGEN George R. Christmas, Deputy Chief of Staff for Manpower and Reserve Affairs, Headquarters Marine Corps.

The statue, which shows a Navy corpsman dragging a marine to safety during World War II, was the result of a unique collaboration between sculptor Wilde and Laing. Laing, a former Navy pharmacist's mate who served in the Pacific during World War II, commissioned the statue because, as far as he knew, there were no such commemorations of corpsmen in the nation's capital. "It is a long overdue tribute to a group of people whose aim was not killing but saving lives," said Laing. Of the sculpture itself, he added, "The sculptor was able to get into my mind and interpret my thoughts. My thoughts were materialized into something physical."

Wilde agreed. "I was part of Dr. Laing's processing of what happened in the war," said Wilde, who added

The ceremony included the traditional "Passing the Helmet."

that the slightly smaller than life scale statue was created from basswood, a light, soft wood, to emphasize the vulnerability of humans.

Although it was Laing's memories and recollections that fueled his creativity, Wilde was also able to create a more personal connection with his work. As he began working on the statue, Wilde was diagnosed with diabetes. While hospitalized, he began to understand his own mortality. He was also able to develop a trust among the nurses and physicians responsible for his welfare. "I took my life experience and put it in context with the statue," said the Canadian-born Wilde, who has held exhibits of his work in Canada, the United States, Germany, and Israel. "I identified with that marine. It (the sculpture) is based in religion in that there is a sacrifice, giving one's life to sacrifice for others."

As the crowd huddled around what had for weeks been a giant surprise package parked in the middle of the hospital's lobby, Christmas, Ridenour, Laing, and Wilde finally unveiled the unprecedented work of art. Amid the applause and tears of remembrance for fallen heroes, the statue received a blessing from two of the hospital's chaplains.

Whether viewed as simply a work of art, a well-deserved tribute to Navy medicine, or as a milestone marker in our nation's history, it is, undeniably, a labor of love and remembrance. Its inscription reads: "This memorial is dedicated to the hospital corpsmen who served with the Marines in the Pacific during World War II. 'Doc' was that special comrade who pulled them to safety, patched their wounds, and shared their foxholes. Established in war and ennobled in peace, this bond will always endure." ❑

—Story by JO3 Kevin M. Briscoe, NNMC Public Affairs Office, Bethesda, MD.

A Dream Fulfilled

The sculpture's benefactor, Dr. Will Laing, served in the Pacific during World War II as a pharmacist's mate and saw the worst of the fighting on Guadalcanal. Over 50 years later he saw a dream fulfilled as the statue honoring Navy corpsmen took its honored place at the National Naval Medical Center, Bethesda, MD. Following are excerpts of Dr. Laing's remarks at the 2 Sept dedication.

"While visiting Washington in 1994, my wife and I walked the length and breath of this great city, visiting every museum and seeing every monument and statue commemorating the brave and the bold. But alas, not a single tribute to the hospital corpsman. I pray now that this memorial will atone for any oversight that may have been made over the past 50 plus years. Now it stands for every American and the whole world to see and understand that war is not always killing, but also saving life with compassion and tender mercy.

"When I look upon this statue, I envision the men it represents, rising from their places. As the battle rages, the corpsman desperately tries to save the life of a wounded marine. Once that marine is safe, the corpsman will again return to the front line to repeat the same act over and over, saving the lives of others that call out, 'Corpsman! Corpsman!' In selfless duty and honor to his profession, his courage and determination will soon empty the battlefield of every single wounded man. After all, he is the epitome of the highest standards of the U.S. Navy and its Medical Department."

Corpsman Up!

Remarks of LGEN George R. Christmas, USMC

It is a privilege and an honor to be with you today and to share in this unveiling of what all of us are going to find is a wonderful work of art. It's a privilege because I have been asked to represent the Navy-Marine Corps team, a team of marines and sailors and their families which Navy medicine each day serves so well. It's an honor because I stand before you because of Navy medicine. And I stand before you because of the physical embrace the corpsman brings to the battlefield in caring for and in saving his marine.

It is a very special bond, a special bond that started in 1775. It's a bond that was there at Belleau Wood during World War I. It's a bond that was with the 5th Marines on Guadalcanal. It's a bond that was at Iwo Jima. A bond that was at the frozen Chosin Reservoir in Korea. And a bond that was truly there with the devastation and tragedy of Beirut. A bond that was there on the desert floor and, while it did not have to be used, it was there and was there in spades. And it's a bond that exists today, a bond of Navy and Marines serving off the coast of Bosnia ready at a moment's notice to do what our nation has for it to do. Or in the refugee camps in Guantanamo Bay side by side—corpsmen and their Marines—a bond.

But just as had been said here, it's an unspoken bond. And why is it that it is unspoken? Perhaps it's unspoken because it's very difficult to describe. It's very difficult to articulate but it is there in such a strong feeling. Perhaps I can describe it in two stories, stories of corpsmen who will go unnamed.

There was a rifle company moving against a North Vietnamese Army force. And by circumstance, that company would walk into an ambush by an entire North Vietnamese Army regiment. Immediately there was the sound one always hears in combat, "Corpsman up!" And up ran the corpsman to a wounded marine just a little bit ahead of the lines which had been drawn. He was down and seriously wounded. And as the corpsman came next to that marine, and put on a life-saving tourniquet which would eventually save the marine's life, a grenade rolled in and exploded, wounding the corpsman. Undaunted, he continued his life-saving actions. Two other grenades came in, one by the corpsman's feet and one just off where he couldn't reach it. He kicked the grenade by his feet and it went off into the bushes. Realizing he couldn't get to the other grenade, he dove so his body was between the exploding grenade and his marine. He was thrown into that same brush only to be wounded by the other grenade as it went off. Yet he still crawled back and, holding onto his marine, and as help arrived, was able to crawl from the battlefield.

Or, it's another unit, a battalion. The corpsman is well back in the battalion. Suddenly, the battalion is struck by enemy fire and a marine is down. And again the cry goes out, "Corpsman up!" And up ran the corpsman from his safety out into a field of blazing fire to reach down with those protective arms to put them around the marine. Unfortunately that day, the blazing fire would cause the good Lord to reach down and take that marine and his doc and lift them into God's loving hands.

A special bond, an unspoken bond? Yes, it is. And it means so much. So from we who serve today, from we who served in the past to those of you who wear the Marine green when you're with us, you are very special. The bond will always be there. And I salute you for what you mean to us.

But to all of us who are gathered here, I would remind you that freedom is not free. And someday again, the call will go out, "Corpsman up!" And we as a nation; we as a people must be prepared and ready to do what corpsmen have done since 1775. To all corpsmen, God bless you. To our great nation, God bless it also.

The Chaplain as Clinician

LCDR William G. Waun, CHC, USN

The new edition of the *Joint Commission on Accreditation of Healthcare Organizations (JCAHO) Manual* is on the street, and the language of the *Manual* reflects its new emphases. For example, the *JCAHO Manual* talks about "considerate care that respects the patient's values and beliefs." Other terms used include "spiritual values," "spiritual beliefs," "spiritual concerns," and "biopsychosocial concerns." Such language reflects the holistic, interdisciplinary impact of postmodern deconstructionism. Consequently, this impact is felt by the changes we are experiencing in the various clinical disciplines.

Like many disciplines within our postmodern society, the chaplaincy is also undergoing rapid change. Authors such as M. Scott Peck and John Bradshaw have revived interest in things spiritual and have put the word "soul" back into our vocabulary. Empirical studies on spirituality are abounding. Such emphases have brought more attention to the role of the chaplain in a hospital setting. As the hospital chaplaincy changes, it is becoming more and more clinical. As a clinician and an integral part of the health care team, what are the unique roles of the hospital chaplain?

•**Hospital chaplains are clergy.** As clergy, chaplains retain the ancient role of ministering to the spiritual and religious needs of patients. Chaplains are the ones who provide the rites and sacraments of the religious faith group by which he or she has been ordained. While it is acknowledged that not all patients who occupy beds in our hospitals are in need of religious ministry, it becomes much more significant when we realize that most of our patients consider themselves to be religious. One empirical study showed that 85 percent of patients in the study rated themselves as moderately highly religious.(*1*) Chaplains are the members of the health care team who tend to patients' spiritual and religious needs.

•**Hospital chaplains are clinicians.** In an insightful article entitled "The Modern Chaplain: On the Cutting Edge of a New Clinical Science,"(*2*) Elisabeth McSherry, M.D., M.P.H., discusses five features of a clinical science and demonstrates how the hospital chaplaincy meets these criteria. For example, along with physicians and nurses, chaplains diagnose. In McSherry's article the chaplain is shown how to use different instruments to diagnose patients' spiritual needs and intervene with appropriate pastoral care. One of these instruments combines the Social Readjustment Rating Scale (based on the work of Holmes and Rahe)(*3*) with additional data used to measure one's spirituality. This instrument is known as the Spiritual Profile Assessment.

Thus, chaplains who know the effects of stressors on the immune system via the hypothalamic-pituitary-endocrine axis (especially the effects of adrenocorticotrophic hormone on the immune system) can have a significant impact on helping a patient back on the road to health. And empirical studies substantiate this. Indeed, studies

in the *HCM Review* in 1986 show that patients with chaplain visits: (1) were discharged 2 days earlier than other patients, (2) required 66 percent less pain medicine, and (3) made 66 percent fewer calls on nursing time.(*4*)

•Hospital chaplains are pastoral counselors. Chaplains provide pastoral counseling as a form of therapy. Pastoral counseling is defined by the American Association of Pastoral Counselors as "a form of therapy or counseling in which a pastoral counselor, as a representative of a religious tradition or community, uses the insights and principles of religion, theology, and modern behavioral sciences in working with individuals . . . toward the achievement of wholeness and health." Many of our hospital chaplains have a subspecialty code in pastoral counseling and have gone through the Pastoral Care and Counseling Residency at Naval Medical Center, Portsmouth, VA.

In terms of object relations theory, for example, in pastoral psychotherapy the chaplain can serve as a transitional object to God.(*5*) With the new category in the DSM IV (§V62.89) addressing the diagnosis "Religious or Spiritual Problem," the chaplain can be of much assistance in providing therapy. Another example has to do with women who are survivors of childhood abuse by a father-figure and have subsequent conflicts in the area of religion.(*6*) A pastoral counselor can help patients identify these issues and assist in working through them. The chaplain is the unique provider of this special type of therapy.

•Hospital chaplains are "pray-ers." Back in the first part of the 19th century, Francis Galton (an early pioneer in the field of psychology and cousin of Charles Darwin) did one of the first studies on the efficacy of prayer. Numerous studies are flooding the journals today. Physicians King and Bushwick in an article published in *The Journal of Family Practice* conclude that patients want their physicians to discuss religion and pray with them.(*7*) Two months earlier another article appeared stating: "Scientific studies now prove what hospital chaplains long have known: prayer helps patients get better and leave hospitals sooner. . . ."(*8*) Chaplains stand ready as the "duty pray-ers," praying not only for our patients, but also for our physicians, nurses, corpsmen, and all other members of the larger health care team.

•Hospital chaplains are ethicists. Chaplains can be excellent resources when making ethical decisions. Seminary training and continuing education include the study of ethics, encompassing biomedical ethics. Chaplains can help by discussing ethical issues with patients and/or health care providers. When deciding whether certain issues are right or wrong, a chaplain's input can prove helpful.

•Hospital chaplains are team-builders and team-players. One of the impacts of postmodernism is its insistence that there are many viable ways of looking at issues. An outgrowth of this concept within the field of medicine can be seen by the encouragement of multidisciplinary committees within hospitals. Chaplains can offer a unique and sometimes fresh view from a slightly different angle when important issues are discussed and decisions made.

A chaplain's knowledge of sacred texts, languages, cultures, history, human behavior, philosophy, etc., enable him/her to be a unique contributor to any discussion. Examples of committees on which chaplains serve include the Executive Steering Committee, Family Advocacy Case Review Subcommittee, the Bioethics Committee, the Quality Improvement Task Force (preparing for the next JCAHO inspection), the Quality of Life Committee, the Resolve through Sharing Committee, the Discharge Planning Committee, and others.

As the chaplaincy moves more in the direction of becoming a clinical discipline, the chaplain's role on the health care team becomes more pronounced and more clinical. Willing to be of service and eager to help, the hospital chaplain and Religious Program Specialist want to support the efforts of the health care team in restoring wholeness to patients and keeping Navy medicine on the cutting edge of modern science.

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Navy Medicine in *Kernel Blitz '95*

CAPT Kenneth L. Andrus, MC, USN
CAPT John K. Taylor, MC, USN
Neil B. Carey, Ph.D.

In the last 5 years, Navy medicine has been a central partner in every Navy contingency, from providing support for humanitarian relief in Haiti, to combat casualty care in Somalia and Zagreb.(*1,2*) Navy medicine's increasing role in contingency operations highlights the need for significant medical participation in fleet and FMF training exercises.

Kernel Blitz '95 (KB '95) provided Navy medicine with its best opportunity in 40 years to be an integral part of a major fleet exercise. The overall objective of KB '95 was to conduct a brigade-sized amphibious assault to prepare the Navy Expeditionary Force to operate effectively in littoral environments.(*3*) The objectives of the medical component of Kernel Blitz, Charlie Golf 1 (CG1), were to:

•maximize training of medical personnel,

•validate medical requirements outlined in the fleet's major regional contingency plans,

•integrate Navy medical planning and execution requirements with those of the line, and

•introduce advanced medical information technologies.(*4*)

The Pacific Fleet, Amphibious Group III, and 1st Marine Expeditionary Force surgeon's offices were intimately involved in planning from inception of the exercise. This allowed for integration of medical into the exercise's major scenario events list. KB '95's medical participation involved nearly 1,000 active duty and reserve force personnel and provided the full range of medical capabilities required to support a major amphibious operation.

Simulated casualties received care commencing with buddy aid and treatment from the corpsmen in the field. With full attention to casualty management and doctrine, these casualties were triaged and then progressed through Echelon II care ashore and afloat, Echelon III care aboard USNS *Mercy*, and Echelon IV care at the

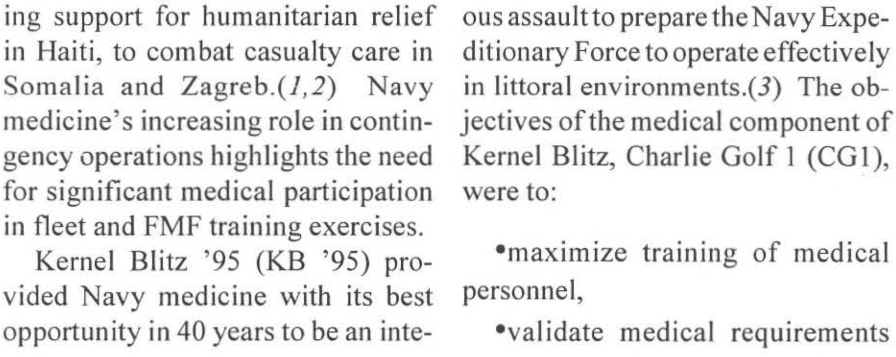

Figure 1. Approximate Positions of MTFs in Kernel Blitz '95

Application of moulage

Fleet Hospital Operation and Training Command (FHOTC) at Camp Pendleton, CA (see map, Figure 1).

The major medical players in KB '95 were 1st Medical Battalion, 1st and 4th Force Service Support Groups, USS *New Orleans,* USS *Peleliu,* USNS *Mercy,* Fleet Hospital 15, and the 126th Medical Air Ambulance Company, 175th Medical Regiment of the California National Guard.

The exercise introduced several innovations regarding combat casualty management. First, casualty treatment scenarios were designed specifically for the exercise by CAPT John Downs, MC, USNR, and LCDR Todd Morris, MC, USNR. They created treatment algorithms for 200 casualties representing the full spectrum of illness and injury that medical personnel would be expected to encounter in a combat environment. These ranged from high-velocity wounds to infectious disease and chemical/biological warfare scenarios. Each algorithm provided specific clinical interventions that had to be performed for the type of injury or illness sustained appropriate for each echelon of care. In this manner the algorithms served as both an evaluation and teaching tool in providing feedback to the participants.

To ensure as realistic an experience as possible for all participants, Walt Disney studios, assisted by field medical school personnel, applied wound moulage to the casualties. The casualties were coached on how to respond to their unique injury or illness. Casualties were triaged, "treated," and provided after-treatment nursing care, just as they would in a real contingency.

Lessons Learned

Training of Medical Personnel. The objective of training medical personnel was attained, given that over 11,000 man-hours of training occurred on *Mercy* alone. Medical personnel provided the full range of medical capabilities needed to support a major amphibious operation. It provided an extremely valuable opportunity for participants, most of whom had never been in a real-world contingency.

KB '95 exposed medical personnel to the stresses they would face in a real operation and forced them to work within the constraints of their "hospital." An integral component of the exercise's realism was that all medical interventions were done in "real time." For example, if a gunshot wound was determined to require 2 hours of operating room time, then the casualty and medical team entered the OR for 2 hours and simulated all those procedures needed to treat that particular wound. Some medical personnel were still "operating" on casualties until 0200 even though the last casualties were received at sunset! This allowed us to validate medical regulation procedures and approximate the time a casualty treatment ship could remain on line before the medical staff became exhausted.

Validation of Medical Requirements Outlined in the Fleet's MRC OPLAN. KB '95 provided an important reality check on the fleet's major wartime contingency operational plan. Thanks to the efforts of RADM M. Eugene Fussell, MC, USNR, Deputy Fleet Surgeon, in getting reserves involved, KB '95 reinforced our understanding of the value of medical reserves as force multipliers. It also highlighted the importance of information flow and situational awareness for medical commanders. Appropriate sections of the communication annex of any OPLAN must specifically consider and prescribe Communications Security Materials System (CMS) custodianship, frequency and band width assignment, and equipment compatibility for medical communications. KB '95 showed that the reliability of some communication equipment needs to be reassessed and improved.

The triage area aboard *Peleliu* was a busy place.

Observations of KB '95 challenged our assumption that operating rooms are the only limiting factor in surgical backlog. By "stressing the system" in this exercise, we found that the availability of intensive care beds for pre- and post-operative care are equally important to the availability of operating rooms. Aboard the Echelon II ships, critical staffing shortages for patient care and administrative functions became a factor beginning the second day of casualty treatment, when new patients were being accepted from the beach while others on the ward were being processed for movement to Echelon III and IV facilities.

Lastly, an extremely valuable component of the exercise was the assessment process to estimate the actual consumption rate of medical materials; this method refined and validated logistic sustainment requirements. These are all factors that must be considered in writing and implementing an OPLAN.

Integration of Navy Medical With the Line. Marine Corps medical units met their exercise objectives including:

•casualty treatment,

•transition of medical support ashore from the Beach Evacuation Station to the Surgical Company, and

•transfer of the medical regulating net from the Commander, Amphibious Task Force to the Commander, Landing Force.

The realism provided for field medical hospital corpsmen *and the combatant forces* by inserting casualties in 15 different combat engagements was particularly noteworthy.

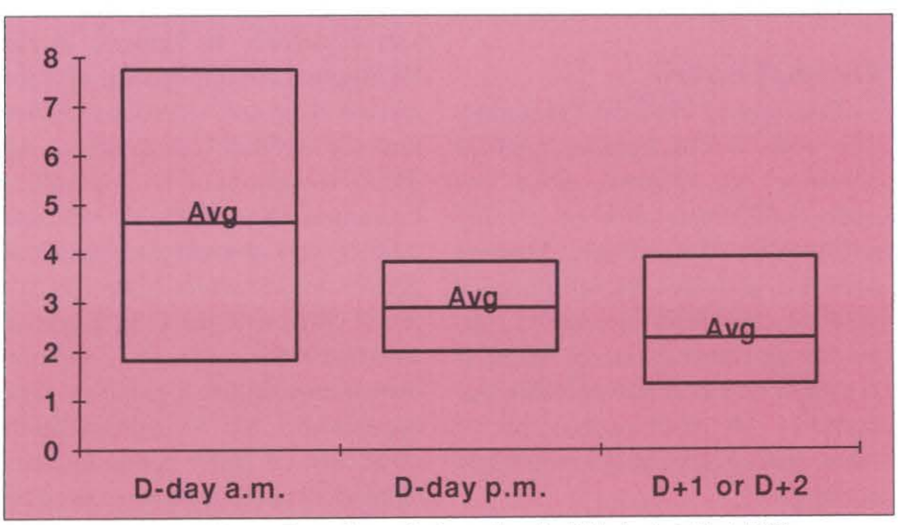

Figure 2. Hours From Casualty Insertion Until Arrival at First MTF

By including a comprehensive medical component for the Marine Ground Combat Element, including Army aeromedical evacuation assets, KB '95 allowed for a realistic assessment of current capabilities and procedures. In particular, we observed a need for better HF communications equipment and coordination between Navy line and landing force medical regulating officers, the Marine Direct Air Support Center, DASC, and the Navy Tactical Air Control Center.

Advanced Medical Information Technologies. KB '95 allowed many new technologies to be brought to theater for the first time. For each of the 200 casualties, a specific algorithm was created, based on the principles of Advanced Trauma Life Support (ATLS). The performance of the medical personnel was evaluated using these algorithms by professional multidisciplinary clinical evaluation groups (CEGs). The feedback to the individual was immediate and specific to preestablished guidelines. An electronic pen-based computer version of the guidelines was made avail-

Surgical procedures were performed aboard *Mercy, New Orleans,* and *Peleliu* (shown here).

able and "alpha tested" during the exercise, and the positive response has led to the full development of a computerized evaluation system.

Additional evaluation was provided by the Naval Doctrine Center, Health Service Support Detachment, Center for Naval Analyses (CNA), members of the Trauma Care Information Management System (TCIMS) consortium, and Advanced Research Project Agency (ARPA). The success of combat casualty care is predicated on the rapid evacuation of casualties. CNA's feedback indicated the significant improvement in casualty management, with average transfer times to definitive care plummeting from about 5 hours down to about 2 hours (Figure 2).

New technology was exercised in other areas of the KB '95 and at all echelons of care. At the casualty generation level, an extensive test of the Multipurpose Automated Reader Card (MARC) technology was undertaken. Casualty demographics were written to the MARC at the generation site and the card then used in the field to record treatment data. Subsequent transfer of the data from MARC to Composite Health Care System (CHCS) embarked on *Mercy, Peleliu,* and FHOTC training sites enabled technicians to demonstrate the true feasibility of using this system in the field for the first time.

Additional telemedicine efforts included live consultations between FHOTC and *Mercy,* transfer of digitized X-rays from the surgical company forward to all other echelons, a live broadcast from the exercise to the Mayo Clinic International Telemedicine Symposium, and the setup of a multitude of technical demonstrations for participant information and interaction both during and "after hours" of the exercise.

Conclusion

Medical participation of KB '95 provided an important training element to this major fleet exercise and demonstrated the benefits to be derived for both medical and line commanders by highlighting those unique aspects of medical support needed for an amphibious assault. Every effort should be made to expand upon the precedents established by this exercise. Further initiatives should focus on a more robust joint medical component to strengthen force integration, address further logistic sustainment requirements, and integrate the new Department of Defense Theater Medical Information Program (TMIP) currently under development.

We must, therefore, pursue a much broader vision of operational medicine that actively seeks to maximize our readiness. We must not only be ready and able to provide day-to-day support to the operational forces, but to integrate our deployable medical platforms and personnel effectively on minimal notice. We must have personnel and command staffs who are ready to perform their duties, and we must provide our personnel with equipment and platforms necessary for them to deliver the highest quality health care possible. The successful execution of the medical portion of KB '95 went a long way toward meeting this challenge.

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Dr. Andrus served as Fleet Surgeon, CINCPACFLT, and took primary initiative for medical play in Kernel Blitz '95. Dr. Taylor, Director of the Readiness Division at Bureau of Medicine and Surgery (MED-27), oversaw the demonstrations of telemedicine during Kernel Blitz. Neil Carey, from the Center for Naval Analyses (CNA), served as a research analyst aboard USS *Peleliu* during the exercise.

The Operations Research Influence in Navy Medicine

LT Thomas W. Dowty, MSC, USN

The future of all military medicine exists in an environment of uncertainty, due to the influences of base downsizing and closures and the uncertain role of the military in future world events. To be effective in such an environment, Navy medicine's decision makers must possess the ability to make decisions even faster than before and with greater accuracy. Decision models supply this ability. Decision models are the tools used to help make decisions. They range from simple mathematical formulas to more complex computer programs developed by operations research (OR) analysts.

OR analysts use calculus-based techniques to produce inferential statistics (a comparison and predictor tool), probability models (forecasting), simulations, economic cost analysis, and optimization (a best trade-off tool). The applied uses of OR include predicting future use of resources, determining the best (optimal) trade-off between competing demands for a fixed supply, and finding the right mix of available inputs that will produce the best outcome. Ultimately, the end result of an OR analyst's work is a flexible, decision tool.

OR's roots are in World War II, where special techniques were developed to help the Allies defeat the enemy. During this era OR analysts were scientists with backgrounds in mathematics or statistics. The OR tools we use today were literally created, in real time, to solve problems faced at the time.

One example of the development and use of OR in World War II is found in the submarine community. The Allies didn't have enough submarines to search the entire Pacific for enemy submarines. OR scientists introduced the technique of Search and Detection Theory which used Markov models. These models provided submarine commanders an accurate ability to predict the locations of moving enemy ships and submarines. This increased the range of submarines 500 percent and allowed the several hundred submarines available to establish an "invisible" net across the Pacific. Due to improvements in these methods, fewer than three dozen submarines are now needed to control the entire Pacific. These methods have civilian applications too. The same Markov models are used by your local weatherman to predict the weather.

Another example of OR during World War II involved the need to determine the true number of enemy tanks Hitler had. Allied intelligence suspected the Germans had 25,000 plus tanks, but OR scientists used the serial numbers from captured German tanks and probability theory to predict that the actual number was closer to 4,000. At

the end of the war, it became known that Hitler had only 3,700 tanks in his arsenal.

The OR community has certainly made a significant impact on the way decisions are made in the line community. Now that influence is being seen in the medical community too. With several research studies to their credit, Navy medicine OR analysts have shown that OR is a valuable science within the Navy medicine community.

The Navy trains OR analysts (as well as Army, Air Force, Marine Corps, Coast Guard, and foreign officers) at the Naval Postgraduate School in Monterey, CA. The OR curriculum consists of 90 credit hours of calculus, economics, computer programming, and specialized OR techniques such as stochastics modeling, mathematical programming, probability, statistics, queuing theory, and simulation. Approximately 150 students complete the 2-year program each year to receive a master of science in operations research.

Several research studies completed as thesis projects by Navy medicine OR analysts address systemwide issues. The first study, completed in June 1990, uses a technique referred to as Data Envelopment Analysis (DEA) which determines the efficiency of a facility from a set of variables that measure the utilization of a set of inputs and their related outputs.(*1*) DEA allows for the comparison of facilities to determine those which are most technologically efficient. DEA could be used to determine measures of effectiveness (MOEs) for a single ward, a clinic, or an entire hospital.

The second thesis project, completed in September 1992, used a technique referred to as Mixed Integer Programming (MIP) to optimize the allocation of OB/GYN physicians.(*2*) The project provided a method of determining the best facilities to locate a given number of OB/GYN physicians in Navy medicine. MIP was also used in a third thesis project completed in September 1994. The project determined the optimal allocation of eligible beneficiaries between direct care and CHAMPUS at the least cost.(*3*) The project determined the most eligible facilities for downsizing and provided support to a DOD study of small hospitals by recommending realignment of the same hospitals as the DOD study.

Yet another research effort by a Navy medicine OR analyst, completed in September 1993, developed a comparison of military staffing to the staffing of a managed care network of similar size and complexity.(*4*) The project provided a practical evaluation of the structure of a military health care system with a primary care emphasis. The project has been a subject of numerous references by other researchers.

Other medical applications of OR range from optimal shift scheduling of nurses to simulations which model entire clinics.(*5*) One technique of OR that has a significant number of applications is that of linear programming. The next few paragraphs present an example of a linear programming problem and a technique to solve it.

Let there be two types of military officers you must recruit. The first are financial officers and the second are patient admin officers. Assume that financial officers cost $100 per year and patient admin officers cost $90. At least 50 total officers must be recruited. If we were to minimize cost, the solution is obvious, recruit 50 patient admin officers. However, there are only 32 available people who want to be patient admin officers and 45 who want to be financial officers. To minimize cost, the solution is to recruit 32 patient admin officers and 18 financial officers.

To complicate matters more, we determine that it takes three units of training time for financial officers and six units of training time for patient admin officers. Further, there are only 190 units of training time available but at least 50 units must be used to make the training department efficient. To show this mathematically, first define the variables. Let X1 be the number of financial officers to train and X2 be the number of patient admin officers to train. Since the objective is to minimize the total cost of all officers recruited, the objective equation is:

Minimize

$$\text{Cost} = 100\,X1 + 90\,X2$$

Subject to: the other issues we discussed which become the constraint equations:

1. Must recruit at least 50 officers in total:
   $X1 + X2 \geq 50$

2. Only 32 available to be patient admin officers:
   $X2 \leq 32$

3. Only 45 available to be financial officers:
   $X1 \leq 45$

4. Total training time must be greater than 50 units:
   $3\,X1 + 6\,X2 \geq 50$

5. Total training time cannot exceed 190 units:
   $3\,X1 + 6\,X2 \leq 190$

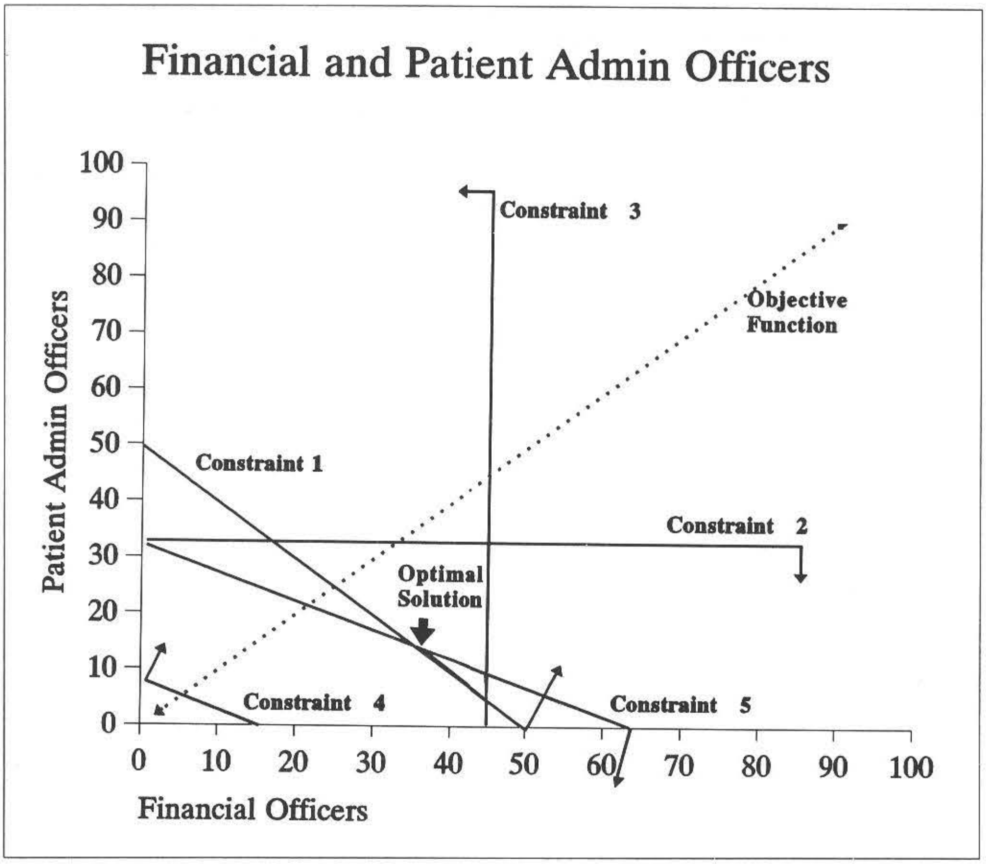

Figure 1

With only two decision variables, the problem can be solved on a two-dimensional graph. The five constraint equations listed define a region that is pictured in Figure 1. Each constraint forms a line. Each line indicates which constraint it represents. The best (optimal) solution to the problem is the minimum point within the region that is created by the constraint lines. The arrows at the end of each line show the area that is confined by the lines. An inspection of Figure 1 shows that constraints 1, 5, and 3 form the solution region. Constraints 2 and 4 are not important in this problem and are referred to as "redundant" constraints. The point where constraint lines 1 and 5 cross is the optimal solution because it is the minimum point (closest to zero) in the solution region. The answer to the problem is 37 financial officers and 13 patient admin officers.

Currently OR analysts are working on economic cost allocation decision models, surveys to measure physician satisfaction, tools to measure how many resources each type of patient uses, and models to determine the best distribution of staff in a facility. And the hull hasn't even been scratched yet! Navy medicine currently has four OR analysts, all working in the Washington, DC, area. They are assigned to the Bureau of Medicine and Surgery. This small community will grow by one or two each year for the next few years. As the community of OR analysts grows and the knowledge of operations research capability spreads, through media such as this, the potential impact of OR on Navy medicine is limitless.

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Stretching the Limits of Naval Self-Sufficiency:

Medical Implications of War at Sea

CAPT Arthur M. Smith, MC, USNR

As demonstrated during the Gulf War, and more recently by security actions in Somalia and Haiti, the employment of U.S. military forces in the post-Cold War period is increasingly directed toward involvement and intervention in Third World regional crises. No longer emphasizing blue-water operations against Soviet ships and deep-interdiction air strikes against the Soviet homeland, the Navy's combat strategy now focuses upon worldwide power projection with the potential requirement for implementing aggressive, sustainable forward operations along the world's coasts and littorals.

The Navy's contingent responsibilities now include insertion of amphibious forces, protection of U.S. property, resupply of friendly governments involved in crises, evacuation of endangered U.S. personnel, patrol and escort operations for friendly shipping, combat against coastal navies threatening friendly shipping, shore bombardment, mine clearing, and even the interpositioning of ships to prevent intervention by another power in local disputes affecting our interests. In every case, consideration of the requirements for medical support is integral to the sustainability and success of any naval combat activity.

Mounting Risks

Traditionally, carrier-based battle groups with an air wing of 80 aircraft and 9 escort ships have supplied the bulk of our Navy's overseas presence and crisis response capability. To meet national security requirements as our naval force contracts, however, alternative operational concepts have evolved, including a decreased number of combatant escorts assigned to deployed carrier battle groups. To maintain regional presence, this has consequently mandated a dispersion of the smaller battle groups over larger geographic areas. Alternative naval force configurations designated "Surface Action Groups" have also evolved, centered around a cruiser, destroyer, or amphibious assault ship.

The transition from a "presence" role to a crisis response or combat role can occur suddenly. As the seriousness of an operational threat increases, risks to "alternative naval configurations" correspondingly increase. These vulnerabilities arise because of inadequate organic air capabilities within surface action groups. Alternative configurations all suffer from either a relative or complete lack of defensive air cover compared to carrier-based groups.

In the event of hostilities in regions where other U.S. forces are not available to ensure air superiority, even a downsized battle group based upon a multipurpose amphibious assault ship cannot avert vulnerability. During the Falklands War of 1982, for example, the British operated a force of two small carriers with air wings actually larger (12-20 Sea Harriers) then those aboard the larger amphibious assault ships in our surface action groups (10-14 AV-8B Harriers). The British naval force nevertheless suffered major defensive vulnerabilities, since the small size of their air wings could not support around-the-clock airborne fighter coverage. Even more crucial was their lack of any airborne early warning.

Alternative U.S. task forces centered upon amphibious assault ships or surface combatants would be exceedingly vulnerable, and the possibility of major casualty accumulation is predictable, since ships will no longer face unsophisticated armaments when deploying to local conflicts. Technology has made *all* battlefields more lethal. Many players around the world now have at their disposal multiple weapons of mass destruction, as well as the means to deliver them at increased ranges and vastly improved probabilities of hit/kill. Other countries' abilities to disrupt our surveillance, electronic in-

Right and opposite page: An errant missile accidently fired on the deck of USS *Enterprise* while the ship was conducting air operations in the Pacific suddenly generated large numbers of dead and injured.


U.S. Navy photos

telligence collection, and early warning capabilities are expected to increase as well. Consequently, when developing a concept for outlining our Navy's role in future military conflict, the sudden massive generation of U.S. casualties is a distinct possibility.

Realities of Casualty Generation at Sea

In the context of personnel safety, naval operations can be highly dangerous undertakings. Even in peacetime, operations at sea contain many hazards. A 30 Mar 1994 news report revealed that superheated steam suddenly leaked through a pipe within the turbine room of the submerged French nuclear submarine *Emeraude* during a naval exercise in the Mediterranean. The commander and nine others were killed either by burning or asphyxiation. On the occasion when combat is superimposed upon this intrinsically precarious operational setting, the delivery of health care could well be heavily compromised and occasionally impossible to accomplish.

Utilizing the predictive data within the Navy's "Afloat Manpower Casualty Assessment Model," with due regard for modern armament capabilities as well as ship design, it is estimated that a single missile hit aboard a *Perry*-class guided missile frigate (FFG) would create between 46 and 76 wounded, with death rates varying between 34 and 204 depending upon the number of additional missile hits and the degree of damage sustained. (This is at some variance with the number of casualties experienced aboard USS *Stark* following two Exocet missile hits, but casualties would probably have been substantially higher if the ship had to be abandoned, especially if the attack had occurred in colder North Atlantic waters.)

An aircraft carrier (CV) hit by a series of torpedoes and missiles could expect wounded numbering as many as 1,700, accompanied by the deaths of 2,670 additional crewmembers. A mobile logistics ship (AOE) attacked with missiles and a torpedo could anticipate 250 wounded and 180 dead. Even a guided missile cruiser (CG) would sustain 167 wounded and 141 deaths under similar circumstances. The nature of casualty estimate models will obviously vary, but *the fundamental reality remains that single ships in wartime are subject to enormous and simultaneous casualty generation.*

In addressing the fundamental components of casualty care delivery at sea, several axiomata apply:

•The severity of injury that can be effectively treated aboard any ship is generally constrained by the limited and often variable adequacy of medical outfitting of ships, as well as by the limits of medical personnel capabilities.

•The number of injured crewmen that can be treated is significantly affected by the limited medical spaces available on any given vessel.

•The maximal limits of survivability of the seriously wounded are ultimately influenced by transfer capability, which is determined both by the tactical situation and the geographic location of the ship relative to other medical resources.

Related secondary explosions during naval conflict can further magnify the generation of casualties. USS *Princeton* (CVL-23), after being struck by an aerial bomb from a kamikaze during World War II, experienced significant blast and fire damage. Casualties included 7 deaths, 191 wounded, and 92 missing. Later that day, USS *Birmingham* (CL-62) came alongside to render aid in salvage. Shortly thereafter, an explosion from the aftersection of *Princeton,* which blew off her stern, swept *Birmingham* with blast, flame, and debris as well, killing or wounding half of her embarked personnel.

Pathogenesis of Naval Combat Injuries

Ballistics research has demonstrated that when a high explosive munition or kinetic energy round penetrates a ship's hull, a spray of hot

fragments emanates from both the munition and defeated metallic hull. These may produce shrapnel-type fragment injuries in crewmembers caught within the penetration path. Within this spray of hot fragments, labeled a "spall cone," a thermal pulse may also occur, igniting any nearby flammable material.

These destructive phenomena are generally accompanied by "blast overpressure" within the adjacent crew space as well, and a brief intense flash. Blunt injury to the bodies of nearby crewmembers may result from being physically accelerated by the motion of the surrounding and collapsing physical structure, while toxic gases are generated by either burning materials or by the munition penetrator itself.

The phenomenon of "blast overpressure" describes the high pressure environment created by exploding munitions. The blast environment is an extremely complex phenomenon caused by shock wave reverberations off of the many surfaces within the path of the penetrating warhead. Primary blast injury entails contusionlike injury to air-containing structures of the body such as lungs, gastrointestinal tract, and ears, as well as their potential rupture.

Optical injury emanating from the intense flash may include permanent retinal injury (scotomata), corneal photokeratitis (welders' flash), corneal surface burns, and temporary flashblindness (after-image).

In a threatening thermal environment, there is variability in the degree of human tissue damage, especially when personnel are protected by clothing. The first 10 seconds after hull penetration are considered the most critical period for burn injury. Clothing offers limited protection in a "brief" thermal environment (other than the highly flammable synthetic fabric, "Certified Navy Twill"). In a "significant" thermal environment, few garments can resist ignition for longer than 10 seconds. (The *Stark* Followup Action Report noted that air temperatures adjacent to shipboard fires may be as high as 1,200 degrees C.)

Following hull penetration, burning projectile propellant combines atmospheric nitrogen and oxygen to form nitric oxide (NO) and nitrogen dioxide (NO2), as does burning aluminum, which also "fixes" atmospheric nitrogen. NO is known to induce methemoglobinemia. NO2, highly soluble in water, is absorbed by the cells of the tracheobronchial tree following deep inspiration, and converted readily into nitric acid, obviously highly caustic to the respiratory passages and lungs. Burning

USS *Stark* (FFG-31) lists to starboard after being hit with an Iraqi-launched Exocet missile.

missile rocket propellant also releases carbon monoxide, another antagonist of hemoglobin oxygen transport. Burning plastics and insulation materials commonly release hydrogen cyanide, yet another recognized hemoglobin toxin, in addition to vaporized hydrochloric acid, formaldehyde, and acrolein.

Most personnel within an attacked vessel undergo strenuous physical exertion. Increased frequency and depth of tidal ventilation within hours of toxic gas exposure increases the propensity to tracheobronchial inhalation injury through exposure of the most distal recesses of the tracheobronchial tree and alveolar membranes to the many vaporized caustic chemicals in the environment. Augmented airway and pulmonary alveolar damage consequently ensue.

Notwithstanding the potential for upper airway burns from the direct effect of thermal injury, the exposed victim is thus predisposed to potentially significant hypoxemia and lactic acidemia from the cumulative impact of tracheobronchial and alveolar toxic injury resulting from the various inhaled agents, noxious alterations to the integrity of hemoglobin itself, and the effects of blast wave injury upon the lung parenchyma.

Blunt injury to a crewman may also occur either by: bulk action of a hull space impacted by an energetic penetrating missile, contact with a structural surface violently deformed by the explosion of an adjacent mine, or after having been thrown into structures or struck by displaced objects.

The implications of these physiologically debilitating events are underlined by noting causes of death aboard *Stark* following its attack by Exocet missiles. Of the 37 fatalities, 13 resulted from burns, 6 from smoke inhalation and asphyxia, and 17 from blast injury. Likewise, when a missile penetrated HMS *Sheffield* during the Falklands War but failed to explode, the searing heat generated by its passage through the hull and into the forward engine room set fire to paint, PVC cable, and other flammable materials. Within 15-20 seconds the ship was full of black, acrid smoke. Twenty men died from this hit, and 24 additional casualties experienced burns and smoke inhalation. The Argentine bombing of the British auxiliary ship, *Sir Galahad,* resulted in the sudden generation of 83 burn victims among a total of 179 casualties!

Naval warfare has continued to evolve since the era of the kamikaze and other relatively unsophisticated, though certainly lethal weaponry. The potential for death and injury at sea has increased in this modern age of *Exocet* and *Harpoon* missile, laser guided munitions launched from aircraft, as well as advanced surface-to-surface missile warfare techniques and sophisticated underwater warfare technology. The advent of new structural materials, fuels, and compartmentalization requirements in navy ships bring new fire scenarios.

In recent years, "advanced materials" (graphite composites, synthetic lubricants, artificial fibers and fabrics, adhesives, matrix systems, and advanced coatings) have played increasingly important roles in military designs. The shipbuilding industry is turning to these materials for use in bulkheads, hull components, and fittings. Unfortunately, many of these "advanced materials" possess significant thermal and flammability properties, as well as the propensity to form toxic by-products upon incineration. Furthermore, fire-effect studies on the integrity of bulkheads separating ship compartments have demonstrated the easy propagation of these particulate by-products of com-

bustion, as well as smoke, through the various conduit systems and wire bundles which penetrate these barriers.

Fire problems on ships vary in accordance with the design and function of these vessels. Whether battle related or accidental, damage is likely to be more severe if the fire occurs in an enclosed space designed to defensively encapsulate personnel and equipment. This is especially true in such high-risk enclosures as submarines. Aboard some newly designed surface ships as well, in response to chemicals weapons defense, the trend in ventilation design is also toward the use of closed loop systems. The closed loop system will make surface ships' fire problems more akin to submarines, with greater concern over toxic gas dissemination.

Within the operational setting, medical services are administered under conditions which differ significantly from those in fixed health care facilities during peacetime. Since most ships are primarily designed to support war missions, the extraction and immediate treatment of casualties during combat must be subordinated to both continuation of the flight and damage control efforts to salvage the integrity of the ship's physical structure in the event of fire, structural damage, or imminent sinking. Delays in the immediate delivery of medical care are inherent in this process, and deterioration of injuries or death are inevitable.

The phenomenon of ship abandonment further complicates the provision of medical care at sea, prompting additional exposures of combat victims to hypothermia, immersion, and underwater blast injury. An Exocet missile, for example, penetrated the hull of a British warship during the Falklands War, generating searing flames and thick smoke, while mortally wounding the vessel's watertight integrity. Amidst the confusion associated with ship abandonment, survivors described the full horror of burning decks, cries of trapped victims, and a precipitant rush into the cold icy sea as the ship was abandoned. The formidable task of evacuating casualties from a 50-foot-high deck, down the listing side of the ship into the life rafts below, was only accomplished with significant difficulty.

During World War II, almost two-thirds of all fatalities at sea were lives lost during the ship abandonment-survival phase of naval combat operations. During the Falklands War, of the 71 life-raft survivors following the torpedo attack upon the Argentine cruiser *General Belgrano* by the British submarine HMS *Conquerer,* 69 suffered from hypothermia and 18 died from this condition. How many of the 300 or more deaths following the attack actually occurred during the survival phase following abandonment is not known, but it probably accounts for the majority.

Off the coast of Okinawa during World War II, the radar picket ship USS *Morrison* (DD-590) was hit by four kamikazes within 10 minutes. Attempts to establish the main battle dressing station in a safe area of the ship became futile. One hospital corpsman was killed and another severely wounded. In the face of existing chaos and extensive wounding, each sailor could only render first aid whenever and wherever possible. Arresting bleeding was the sole objective of any aid rendered. The ship began to sink rapidly, and the survivors spent hours in the water. Among them were 90 injured, their wounds often masked by a heavy layer of fuel oil. The medical officer and remaining corpsman could only swim from group to group, offering encouragement and what little aid was possible under the extreme circumstances.

"Immersion blast exposure" is an additional cause of injury and death among waterborne survivors. In October 1967, Egyptian missile boats using Styx missiles attacked and sank the Israeli destroyer *Eilat* opposite Port Said, Egypt. While the surviving crewmembers struggled in the water, the Egyptians fired another missile that missed the destroyer and exploded in the water nearby. Of the 32 *Eilat* sailors rescued after the explosion, most suffered significant injuries of gas-filled abdominal viscera, as well as pulmonary injuries, without any external signs of bruising or injury. Most required emergency surgery. These survivors had experienced "immersion blast injury," a phenomenon rarely seen in peacetime, but long documented in military medical history.

During World War II, repeated dive-bombing and torpedo attacks on ships often left the majority of a ship's company in the water after a direct hit. On those occasions where a depth charge, mine, or torpedo exploded near swimming survivors, grave danger to life existed from water blast, and death frequently occurred.

Rendering Care at Sea: What Is Involved

Off the coast of Vietnam at Yankee Station, a Zuni rocket was accidentally fired on the flight deck of USS *Forrestal,* instantly killing 134 and injuring 162. How can such casualty volumes be effectively managed solely within afloat units? Although some Navy combatant ships are equipped and manned to provide initial surgical care to the combat wounded, these functions may often be subordinated to their primary combat mission. During war, the modern aircraft carrier, often heavily involved

Following her collision with USS *John F. Kennedy* (CVAN-65), highly volatile aviation fuel from the carrier poured down *USS Belknap*'s (CG-26), stacks resulting in explosions, fire, and instant mass casualties.

in offensive operations, can hardly afford to stand by for sustained reception of large numbers of casualties. Likewise, the larger amphibious ships, although theoretically capable of assuming responsibility for large amounts of casualty care, remain relatively untested other than the aging helicopter assault ships (LPHs) that supported U.S. combat operations in Grenada and Lebanon in 1983. (Their own history does not provide an overly sanguine prognosis for mass casualty management at sea.)

The newer *Tarawa* and *Wasp* class amphibious assault ships are endowed with large medical support facilities. Despite the *Wasp*'s 6 operating rooms, 17 intensive care beds, 47 ward beds, and 536-bed overflow capacity, can the capability of this newest class amphibious assault vessel medical facility be equated with a land-based civilian trauma care center with equivalent numbers of patient care units? Are the finite numbers of deployed medical personnel and logistically restricted afloat medical assets aboard the *Wasp* class vessels truly equivalent to land-based hospital facilities? In reality, the capabilities and limitations of these sea-based facilities are substantially different, and "limited" management of casualties at sea would be a more realistic expectation.(*1,2*)

No naval ship other than a fully outfitted and staffed hospital ship (AH) can completely manage the dimensions of complexity of the casualty load expected in naval engagements. Even a hospital ship would be heavily taxed if more than a small proportion of the injuries were critical, as evidenced by the logistical and manpower burden imposed upon land-based civilian emergency facilities during mass casualty or casualty overload situations.

Future for Hospital Ships Is Precarious

Is there still a role for hospital ships in modern naval warfare? At the outset of Operation Restore Hope, the Joint Chiefs of Staff declined to order the deployment of our hospital ships in support of early military insertions into Somalia. Earlier activation of these ships during Operations Desert Shield and Desert Storm required a major personnel augmentation, drawn primarily from shore-based Navy medical facilities. Consequently, mobilizing these vessels implies large financial expenditure, primarily to cover patient-care responsibilities vacated by the health care augmentees. Furthermore, getting hospital ships under way sends a clear message to the American public: military leadership acknowledges and anticipates the possibility of large numbers of major casualties. Hence, despite the yearly expenditure of $6.2 million per ship to maintain a high state of readiness for treating combat casualties, sailing orders for these ships are limited by significant economic and political implications. There are military considerations as well!

During World War II the Navy deployed 14 hospital ships and 3 hospital transports. Subsequently, the Vietnam war provided an ideal geographic setting and combat scenario for hospital ships: intermittent low-level warfare with the combat zone adjacent to the sea, in a long, narrow country with a substantial length of coastline. The enemy failed to interdict our Red Cross-marked hospital ships that sailed freely, immediately offshore. In addition, because of the air superiority which U.S. forces enjoyed, the helicopter could be used extensively, the ideal medical evacuation system for hospital ships.

The modern naval warfare environment, however, is growing increasingly unpredictable and dangerous. Unbridled offensive capabilities now threaten noncombatant ships that stray within range of satellite and sonar detection, long-range remote-controlled rocket propelled missiles, and homing torpedoes. Notwithstanding an increasing tendency toward implementation of sophisticated sea mining activities in littoral waters, many weapons fired on the strength of any sensor other than the human eye may be blind to the white color of a ship's paint or the brightness of her lights. Nonbelligerent hospital ships committed to caring for the sick and wounded during military contingencies may, therefore, no longer enjoy a privileged immunity.

The harsh and unpredictable nature of contemporary missile-based naval warfare, exemplified by the mistaken strike on the Iranian passenger jet by the electronically sophisticated Aegis cruiser, USS *Vincennes* (CG-49), demonstrates the urgent need to consider the safety, effectiveness, and survivability of unarmed ships dedicated exclusively to the care of the combat wounded.

It takes less technological sophis-

tication to detect a radar or transponder signal than to identify the message carried on the signal. Consequently, a less technologically advanced adversary might use such raw signal information to guide a homing missile on target, without ever appreciating its origin from a neutral vessel.

In the future, without the benefits of "protected neutrality," hospital ships may be forced, for purposes of protection, to give way to their only other option—geographic dispersion. This option, however, will only prove counterproductive to their principal mission of forward casualty support.

Naval Sustainability Still Needs Land-Based Support

In reality, afloat medical support services do not exist in a vacuum. There is an inextricable relationship between events at sea and those on land. Land will frequently determine whether a navy has the overseas infrastructure, including medical logistic support bases, to undergird its deployments. During the Falklands War, the number of British shipboard casualties at times exceeded casualties ashore. Serious shipboard casualties occasionally required evacuation to the combat zone hospital ashore for initial stabilization. In addition, the British Navy acquired a neutral land-based staging point in Montevideo, Uruguay, to transfer 593 casualties from the task force. This allowed medical facilities afloat to prepare for the arrival of new casualties.

From the medical perspective, advanced facilities on land are critical to the support of naval warfare. Fleet hospitals serve as one such arm of support. In the matured theater of operations that existed during the latter stages of World War II, large numbers of mobile, base, and fleet hospitals were located overseas. Their value to the fleet was highlighted during the invasion of Okinawa, when kamikaze attacks on the Fifth Fleet created high numbers of casualties among the forces afloat. For continuity of naval operations, six hospital ship transports were required for evacuating the mounting shipboard casualties to Navy hospitals in Guam. During Operations Desert Shield and Desert Storm, three large fleet hospitals were erected in-theater to support both land- and sea-based operations.

Lest we forget, however, there will be few wars similar to the recent Persian Gulf conflict in terms of uncontested buildup of troops, virtually unlimited local fuel, and the unrestricted use of modern seaport and airfield facilities. Unfortunately, as military access to overseas bases such as those previously located at Subic Bay becomes more restricted, overflight rights may become increasingly denied as well, and freedom of navigation may be contested more frequently.

Political considerations may dictate the availability of logistics staging sites ashore, and when a situation is considered politically unfavorable, even our friends may refuse to help. France and Spain, for example, refused overflight rights to U.S. F-111 aircraft during U.S. attacks upon Libya in 1986, because they considered such operations as contrary to their national interests. The potential availability of long-term logistical support for our forces at sea, including medical support, thus will diminish and with it the highly touted self-sufficiency of our modern Navy forces.

History has demonstrated that injuries incurred during naval warfare are complex, and that support systems for their care are generally few and far between. Consequently, it can be said that ultimately, any Navy can go to war, but staying there is another thing, especially after the first casualties start arriving!

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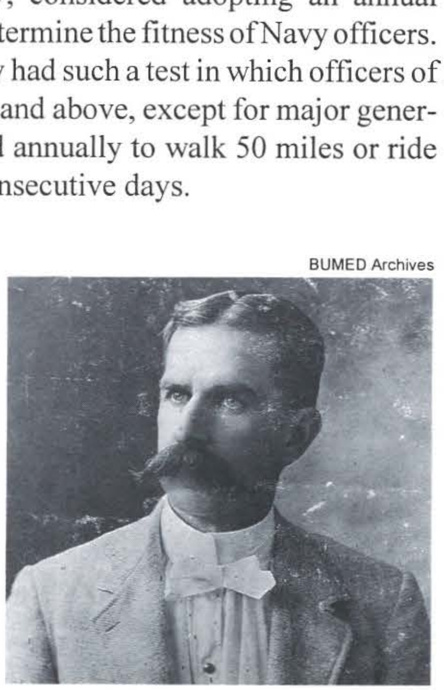
Physical Readiness According to Teddy

That Theodore Roosevelt was fanatical about physical fitness is well known. Plagued by asthma and other maladies in his youth, Roosevelt had spent his adult years building his body by rigorous exercise and the outdoor life. Rancher, sportsman, big game hunter, explorer, and Rough Rider, the 26th President became the nation's leading advocate of what he called "the strenuous life."

Shortly before leaving the White House following his second term, Roosevelt, a former Assistant Secretary of the Navy, considered adopting an annual physical test to determine the fitness of Navy officers. The Army already had such a test in which officers of the rank of major and above, except for major generals, were required annually to walk 50 miles or ride 100 miles in 3 consecutive days.

BUMED Archives



RADM Presley M. Rixey

After much discussion, the Bureau of Navigation drafted instructions for such a test and submitted them to the President. Roosevelt then sought the counsel of his White House physician and friend, Surgeon General of the Navy Presley M. Rixey. Rixey, an avid riding companion of the President, decided to do the Army one better. He told the President he would ride the 100 miles in 1 day rather than 3. Never one to miss an opportunity to test his physical mettle, Roosevelt said he would go along. One can almost hear the Chief Executive exclaiming, "A bully idea!," as he squinted gleefully beneath his spectacles.

Concerned for his patient's health and the possibility of an accident, RADM Rixey vigorously tried to dissuade Roosevelt from going along but all protestations were for nought. This was an adventure not to be missed.

Rixey secured maps to Warrenton, VA, some 52 miles southwest of Washington and arranged for securing fresh horses along the way.

On the dark, cold morning of 13 Jan 1909 Roosevelt, Rixey, Army CAPT Archibald W. Butt, LT Carey Grayson, MC,* and several body guards mounted cavalry horses and began their ride. With the mercury hovering near 30 degrees, they changed mounts at

*Grayson later became personal physician to President Woodrow Wilson and attended him in his last illness.

Courtesy Warrenton Public Library

President Roosevelt responded to Warrenton's hospitality by sending the town this photograph of himself dressed in hunting clothes. The photo, in the collection of the Warrenton Public Library, was taken from a painting by Gari Melchers.

Fairfax Court House, at a farm house near Manassas, and again at Buckland, arriving at Warrenton at 12 noon.

The news of the President's visit spread like wildfire. Schools were let out and soon crowds thronged the top of Court House Hill. Retired Navy physician Dr. John Wise, a personal friend of Roosevelt, welcomed the Presidential party and hosted a luncheon at the Warren Green Hotel.

The President and his companions began their ride back to Washington at 1:20. Changing horses at the same stops along the way, they retraced their journey. At Centreville the threatening overcast that had obscured the sun all day finally turned to precipitation. In a letter later written to CAPT Butt, Roosevelt reminded the young officer of their winter adventure:

> A blinding sleet storm drove in our faces, and from Fairfax Court-House, we were in pitch darkness going over the frozen roads through the sleet storm. You and Dr. Rixey alternately led the way and set the pace. You as well as the rest of the party returned in fine condition, convincing me of the fact that the test provided for the army and navy was not excessive.(1)

After riding the last 30 miles in the teeth of the storm, the party reached the White House at 8:40 p.m., none the worse for wear, if we take the President's account at face value. None of the others left an account but 16 hours in the saddle must have provided several days of aching muscles. As his companions learned the hard way, exercise, according to Teddy, was not to be taken lightly.—JKH

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Women's Health in the Operational Forces:

Problems With Urination

CDR Michael John Hughey, MC, USNR

The health care of women in operational settings often involves treating disorders of urination. Most of these disorders can be diagnosed using only historical information and basic physical exam techniques. A few others will require additional laboratory testing which may or may not be available in the operational arena.

Painful Urination

Painful urination is one of the classic symptoms of bladder infection, along with frequency, urgency, and sometimes hematuria. Such an infection can be confirmed by a positive urine culture (>100,000 colonies/ml), or strongly supported by a positive "dipstick" (for bacteria or leukocyte esterase) and a clinical tender bladder (normally the bladder is not tender at all). Bladder infections are treated with broad-spectrum oral antibiotics (Gantrisin, Bactrim DS, ampicillin, Keflex, Macrodantin, etc.). Immediate relief of symptoms will occur with Pyridium 200 mg PO TID for 2 days.

Gonorrheal Urethritis

Urinary frequency and burning in a patient with a history of exposure to gonorrhea suggests gonorrheal urethritis. Purulent discharge from urethra and Skein's ducts, paraurethral abscesses, and eversion of urethral epithelium are the significant findings. This diagnosis is confirmed by gram-negative intracellular diplococci on Gram's stain or positive culture on Thayer-martin media (chocolate agar). Treatment is Ceftriaxone 250 mg IM plus doxycycline 100 mg PO BID x 7 days. Sexual partners also need to be treated. Skein's abscesses should have I&D followed by daily packing with iodoform gauze for 2-4 days.

Nongonorrheal Urethritis

The patients complain of symptoms suggesting cystitis (frequency, burning, and urgency), but the urine culture is negative and they do not improve on conventional antibiotic therapy. A purulent discharge from the urethra may or may not be present, but the urethra is tender to touch.

Cultures from the urethra may be positive for chlamydia, Mycoplasma, or Ureaplasma, but will be negative for gonorrhea. Treatment may be started on the basis of clinical suspicion alone.

Treatment is doxycycline 100 mg PO BID for 7 days, of tetracycline 500 mg PO QID for 7-10 days, or clindamycin 150 mg PO TID for 7-10 days. Sexual partners also need to be treated.

Herpes

Painful urination in which the vulva burns when the urine drips across it can be the primary symptom of herpes. In this case, inspecting the vulva will reveal multiple, small (1-2 mm), tender ulcers filled with grayish material and perhaps some blisters that have not yet ruptured. The treatment is Zovirax 200 mg PO every 4 hours while awake x 10 days.

Yeast, Trichomonas

Pain on the vulva when urine passes over it can also be a symptom of yeast and less commonly Trichomonas. These infections should be apparent on inspection of the vulva/vagina and may be confirmed by microscopic examination of vaginal discharge.

Painful urination may also be a symptom of other gynecologic disease, not specifically related to the bladder. Endometriosis, for example, may initially present as

painful urination with a tender bladder which does not respond to typical antibiotic therapy and all urine cultures will be negative.

Urinary Frequency

The overwhelming number of patients complaining of urinary frequency will have one of the following problems:

- •Bladder infection accompanied by dysuria.
- •Excessive fluid intake particularly just before bedtime.
- •Be experiencing increased stress.
- •Some pelvic mass which is pressing on the bladder.

Evaluation of urinary frequency involves asking the patient about her fluid intake habits and recent exposure to stress. A physical exam determines the presence/absence of:

- •Bladder tenderness (suggesting cystitis or endometriosis)
- •Pelvic mass (suggesting ovarian cyst, pregnancy, or fibroids)

In situations where the diagnosis is unclear, a urine culture or urine "dipstick" for bacteria, nitrates, or leukocyte esterase may be helpful in identifying infection. A pregnancy test is sometimes enlightening.

Whenever infection is suggested, a course of oral broad-spectrum antibiotics is advised. If no infection is apparent and the patient acknowledges large fluid intake, reducing the intake some may be helpful. (Don't overreact to this . . . too little fluid intake can be a problem also.)

Blood in the Urine

There are a wealth of reasons for blood in the urine. In women of childbearing age, the most frequent is cystitis or a bladder infection. Such an infection is usually accompanied by urinary frequency and painful urination. The bladder is tender to palpation and urine culture will be positive (>100,000 colonies/ml). Urine "dipstick" will be positive for bacteria, nitrates, and leukocyte esterase in the typical case.

Treatment involves an oral broad-spectrum antibiotic (Gantrisin, Bactrim, ampicillin, Keflex, Macrodantin, etc.).

If all symptoms resolve and the hematuria does not return, no further evaluation is necessary. If the hematuria does not disappear or if the patient has repeated episodes of hematuria, then urologic consultation will be necessary to look for other causes of hematuria (renal stones, bladder polyps, bladder cancer, endometriosis, etc.).

Bad Urinary Odor

This is usually a symptom of either a urinary tract infection (cystitis) or a vaginal infection. Examining the patient to determine the presence or absence of Gardnerella, Trichomonas, yeast, or a lost tampon may be helpful in excluding vaginal problems. A urine culture or urine "dipstick" for bacteria, nitrates, or leukocyte esterase may be helpful in eliminating a bladder infection as the cause of the problem.

Certain foods are associated with an unusual odor in the urine (asparagus), as are certain antibiotics (ampicillin).

Cannot Urinate

If the patient cannot urinate at all, she will be in extreme distress with a distended, tender bladder. Insert a Foley catheter and allow the urine to begin draining. After the first 500 cc of urine has drained, clamp the Foley to temporarily stop draining for 5-10 minutes before allowing another 500 cc to drain. Continue to drain the urine in 500 cc increments until empty. Severe bladder cramps can occur if the entire bladder is drained at one time of a large amount (>1,000 cc) of urine.

After the bladder is drained, leave the Foley catheter in place for a day or two to allow the bladder to regain its tone.

Try to determine why the patient couldn't void. She may have recently undergone pelvic surgery which caused swelling in the area of the bladder or urethra, obstructing flow. She may have a pelvic mass (ovarian cyst, uterine fibroids, pregnancy, etc.) which has distorted the anatomy and functionally blocked the urethra. She may have herpes and cannot urinate because of the severe pain which is caused by urine flowing over open ulcers.

Bladder Training

After a day or two, remove the Foley catheter. Usually the patient will be able to urinate normally again. If there is any doubt, catheterize her for "residual volumes (VR)." After she urinates, insert a catheter to completely empty the bladder. If the RV is less than 50 cc, no further catheterization is necessary. If the RV is less than 50 cc, continue to catheterize her after each urination until the

RV is less than 50 cc. If the RV is quite large (>300 cc), then the bladder has probably not regained its normal tone and you should simply leave the Foley catheter in place for a few more days.

Loss of Urine

There are four primary forms of urinary incontinence:

•Loss of urine when coughing, sneezing, or straining ("stress urinary incontinence").

•Sudden, involuntary loss of urine accompanied by urgency (unstable bladder, irritable bladder, detrusor dyssynergia).

•Involuntary loss of urine upon rising or standing.

•Involuntary loss of urine at unpredictable times, not associated with urgency, frequency, or other activities.

Stress Incontinence

Loss of urine when straining (stress urinary incontinence) affects nearly all women at some time in their life. If a woman's bladder is full enough and she strains hard enough, some urine will escape, due to the shortness of her urethra, the fragility of the normal continence mechanism, and its vulnerability to trauma during intercourse and childbirth. Genuine stress incontinence which occurs more or less daily and requires the patient to wear a pad to avoid soiling her clothing will require gynecologic or urologic consultation and usually surgery to repair. Lesser degrees of stress incontinence can be treated by:

•Kegel exercises (periodic tightening of the muscles of the pelvic floor 10-15 times a day x 4 weeks).

•Frequent emptying of the bladder and "double voiding" (reemptying the bladder 10-15 minutes after the initial void) to keep the bladder as empty as possible.

•Elimination of caffeine, alcohol, and tobacco (common bladder irritants) which may aggravate the incontinence.

•A course of oral antibiotics to eliminate the chance that a subclinical cystitis is aggravating the incontinence.

Irritable Bladder

Women with an "irritable bladder" will complain that when they suddenly get the urge to urinate, they must find a bathroom within 1-2 minutes or else they will actually lose urine involuntarily. Evaluation of the irritable bladder will require gynecologic consultation, but a number of simple things can be done to relieve the symptoms while awaiting consultation. Eliminating caffeine, alcohol, and tobacco from the diet will reduce the stimulation of the bladder wall. "Double voiding" (emptying the bladder, waiting 10-15 minutes and then emptying the bladder again) will help fully empty the bladder and will reduce the stimulus. A course of oral antibiotic may eliminate any subclinical infection.

Urethral Diverticulum

Involuntary loss of urine upon standing or arising suggests the presence of a urethral diverticulum. This outpouching of the urethra collects and holds urine, releasing it at unpredictable times. Specialized instruments are needed to visualize most urethral diverticula, and patients with this type of complaint should be evaluated through a gynecology or urology consultation. Nothing short of surgery is likely to help this particular problem.

Unpredictable Urine Loss

Unpredictable loss of urine not associated with urgency or activity suggests a neurologic cause. Such conditions as multiple sclerosis, spinal cord tumors, spinal disk compression, and other neurologic problems should be considered. If a patient has a single episode of this type of urine loss, she can simply be reassured, but if she notes an ongoing or worsening problem with this type of urine loss, careful neurologic evaluation should be performed.

Urinary Urgency

There are three primary reasons for urinary urgency:

•Cystitis (bladder infection)

•Irritable bladder (unstable bladder, detrusor dyssynergia)

•Stress

In women of childbearing age, cystitis is the most frequent cause of this distressing symptom in which a patient suddenly has a powerful urge to urinate. Bladder infection is usually accompanied by urinary frequency and painful urination. The bladder is tender to palpation and urine culture is positive (>100,000 colonies/ml). Urine "dipstick" will be positive for bacteria, nitrates, and leukocyte esterase in the typical case.

Treatment involves an oral broad-spectrum antibiotic (Gantrisin, Bactrim, ampicillin, Keflex, Macrodantin,

etc.). If all symptoms resolve, no further evaluation is necessary. Persistent symptoms will usually necessitate a gynecologic or urologic consultation.

Stress

Women who suffer from stress-induced urgency may benefit from counseling and stress-reduction techniques.

Pyelonephritis

A kidney infection. These infections are characterized by CVA pain or tenderness, chills, fever, lassitude, and sometimes nausea and vomiting. They may be preceded by cystitis or may come without warning.

Treatment is vigorous antibiotic therapy (frequently IV antibiotic because of the seriousness of the illness) and brisk fluid intake (IV or PO).

As in most areas of medicine, there may be more than one way to deal with any particular gynecologic problem. Although one basic approach was given here, there may be other approaches which will give very good or superior results. ❑

CDR Hughey is a Naval Reserve obstetrician/gynecologist in private practice as a Senior Attending Physician at Evanston Hospital (Illinois) and Assistant Professor of Obstetrics & Gynecology at Northwestern University School of Medicine.

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Naval Medical Research and Development Command Highlights

•Laboratory in Peru Investigates Dengue Outbreak

Dengue is a major infectious disease threat to the U.S. military. During World War II, Vietnam, and as recently as Operation Restore Hope in Somalia, dengue was a major cause of acute febrile disease resulting in substantial loss of manpower. Dengue is widely distributed throughout the tropics and subtropics in Asia, Africa, and Central and South America. The intensity of transmission has increased dramatically in Central and South America over the past decade. At the request of the Peruvian Ministry of Health (MOH), researchers at the Naval Medical Research Institute Detachment in Peru are investigating a recent dengue outbreak in the northern part of the country. The research staff and MOH plan to carry out a survey to obtain baseline data on the type and frequency of dengue antibodies among selected communities. Researchers have already isolated dengue II virus (dengue fever can be caused by any one of four different serotypes of dengue virus) that could lead to cases of dengue hemorraghic fever. A primary infection with one serotype appears to confer life-long immunity against reinfection with the same serotype, but does not produce long-lasting cross-protective immunity against the other serotypes. Dengue hemorrhagic fever occurs most frequently in patients experiencing a secondary dengue infection and can be fatal. The goals of this cooperative study is to conduct investigations that will provide a better understanding of the risks associated with dengue hemorraghic fever.

♦ ♦ ♦

•Headsets Evaluated for Use by Sensor Operators in the Navy's P3-C Community

High levels of noise present at sensor operator stations in Navy P3-C aircraft interfere with specialized acoustic monitoring tasks. The lack of sufficient noise suppression degrades overall system effectiveness, can reduce operator performance, and produce auditory fatigue during long-duration flights. At the request of the Naval Air Warfare Center Aircraft Division researchers at the Naval Aerospace Medical Research Laboratory, Pensacola, FL, evaluated a modified active noise reduction headset. Volunteers from the Naval Aviation Flight Training Program participated in sound attenuation and speech intelligibility tests. A comparison of the sound attenuation values obtained with the headset "on" to values obtained with the headset "off" revealed 10-15 dB greater attenuation at 125, 150, and 500 Hz, and 1-5 dB less attenuation at 1,000 and 2,000 Hz. Speech intelligibility scores obtained with the headset "on" were 10 percent greater than scores obtained with the headset "off" at the two highest noise levels. The results were instrumental in the Navy's decision to proceed with further development and procurement of the headset.

♦ ♦ ♦

•Computer-Based Medical Training for Medical Support Personnel Attached to Special Operations Forces

Group medical training for primary medical-care personnel attached to Special Operations forces is impractical because of frequent deployments for extended periods of time. However, training and certification in certain subject areas are still required. Scientists at the Naval Health Research Center, San Diego, CA, are developing a computer-based, self-taught, medical training system as an alternative to classroom training and testing. The first prototype system, released in 1994, consisted of three training modules that were successfully tested in the field by Naval Special Warfare corpsmen. The second system, released in March 1995 for further testing and user feedback, was distributed to medical personnel attached to Navy, Marine Corps, Air Force, and Army Special Operations forces. The second system contains 18 modules, with approximately 100 question-and-answer items. Each module was authored by a medical officer or senior hospital corpsman with special knowledge of the subject areas. Examples of modules include advanced trauma life support, basic cardiac life support, casualty management, emergency medicine, medical management of biological and chemical casualties, pharmacology, sick call medicine, wilderness medicine, and tropical medicine.

For more information on these and other research efforts contact Doris M. Ryan, Deputy Director, External Relations, at DSN 295-0815, Commercial 301-295-0815, FAX 301-295-4033, or E-mail RDC03B@NMRDC1.NMRDC.NNMC.NAVY.MIL.

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Correction

In the *NAVY MEDICINE* September-October issue on page 19, Figure 2 should read Figure 1.

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